We Claim:

1. An apparatus for analyzing chemical species comprising:

(a) at least two vacuum stages, each of said vacuum stages having means for pumping away gas to produce a partial vacuum,

(b) an ion source for producing ions and delivering said ions into said first of said vacuum pumping stages,

(c) at least one multipole ion guide comprising a plurality of parallel poles and an internal volume defined therein by said plurality of parallel poles, said at least one multipole ion guide being located in at least one of said vacuum pumping stages,

(d) a means for applying electrical voltages to said poles of said at least one multipole ion guide, said electrical voltages having AC and DC components,

(e) means for moving said ions into said region of at least one multipole ion guide,

(f) electrode elements located at the entrance an exit ends of said at least one multipole ion guide,

(g). means for applying electrical voltages on said electrode elements,

(h) a Time-Of-Flight mass analyzer and detector located in at least one of said vacuum stages,

(f.) a means for controlling said electrical voltages applied to said poles of said at least one multipole ion guide and a means for controlling said electrical voltages applied to said electrode elements such that selected m/z values of said ions produced by said ion source are fragmented in said internal volume of at least one multipole ion guide and at least a portion of

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said fragment ions are directed to said Time-of-Flight mass analyzer and detector for mass analysis.

2. An apparatus according to claim 1, wherein said Time-Of-Flight mass analyzer pulses said ions into said Time-Of-Flight flight tube in a direction which is substantially orthogonal to the axis along which said ions are directed from said at least one multipole ion guide into said Time-Of-Flight pulsing region.

3. An apparatus according to claim 1, wherein said Time-Of-Flight mass analyzer pulses said ions into said Time-Of-Flight flight tube in a direction which is substantially parallel to the axis along which said ions are directed from said at least one multipole ion guide into said Time-Of-Flight pulsing region.

4. An apparatus according to claim 1, wherein said ion source produces ions at substantially atmospheric pressure.

5. An apparatus according to claim 1, wherein said ion source is an Electrospray ion source.

6. An apparatus according to claim 1, wherein said ion source is an atmospheric pressure chemical ionization source.

7. An apparatus according to claim 1, wherein said ion source is an Inductively Coupled Plasma ion source.

8. An apparatus according to claim 1, wherein said ion source is a glow discharge ion source.

9. An apparatus according to claim 1, wherein said at least one multipole ion guide begins and ends in one of said vacuum stages.

10. An apparatus according to claim 1, wherein said at least one multipole ion guide extends continuously into at least two of said vacuum stages.

11. An apparatus according to claim 1, wherein said at least one multipole ion guide is configured as a quadrupole.

12. An apparatus according to claim 1, wherein said at least one multipole ion guide is configured as a hexapole.

13. An apparatus according to claim 1, wherein said at least one multipole ion guide is configured as an octapole.

14. An apparatus according to claim 1, wherein said at least one multipole ion guide is configured with a number of said parallel poles greater than 8.

15. An apparatus according to claim 1, wherein said a means for controlling said electrical voltages applied to said poles of said at least one multipole ion guide and a means for controlling said electrical voltages applied to said electrode elements can be set to trap ions in said at least one multipole ion guide.

16. An apparatus according to claim 1, wherein said a means for controlling said electrical voltages applied to said poles of said at least one multipole ion guide and a means for controlling said electrical voltages applied to said electrode elements can be adjusted to cause fragmentation of said selected m/z values of said ions in said internal volume of said at least one multipole ion guide by Collision Induced Dissociation of said ions with neutral background molecules.

17. An apparatus according to claim 16, wherein said Collisional Induced Dissociation of said selected m/z values of said ions is caused by resonant frequency excitation.

18. An apparatus according to claim 16, wherein said selected m/z values of said ions are trapped in said at least one multipole ion guide.

19. An apparatus according to claim 18, wherein said Collisional Induced Dissociation of said ions trapped in said at least one multipole ion guide is achieved by the steps of releasing ions from said exit end of said at least one multipole ion guide, increasing the energy of said ions outside said internal volume of said multipole ion guide, accelerating said ions back into said exit end of said at least one multipole ion guide with said increased translational energy, wherein said accelerated ions collide with said neutral background molecules in said internal volume of said at least one multipole ion guide as said ions traverse a portion of said multipole ion guide length moving from said exit to said entrance end of said at least one multipole ion guide

20. An apparatus according to claim 18, wherein said Collisional Induced Dissociation of said ions trapped in said at least one multipole ion guide is achieved by filling said at least one multipole ion guide operated in said trapping mode with said ions until said fragmentation of a portion of said ions occurs.

21. An apparatus according to claim 1, wherein a portion of said internal volume of said at least one multipole ion guide has a pressure in the range of 10^{-4} to 10^{-2} torr.

22. An apparatus according to claim 1, wherein a portion of said internal volume of said at least one multipole ion guide has a pressure in the range of 10^{-4} to 10^{-1} torr.

23. An apparatus according to claim 1, wherein said a means for controlling said electrical voltages applied to said poles of said at least one multipole ion guide and a means for

controlling said electrical voltages applied to said electrode elements can be adjusted to select the range of m/z values of said ions transmitted through or trapped in said at least one said multipole ion guide.

24. An apparatus according to claim 23, wherein said means to select said range of m/z values of said ions includes resonant frequency ejection of unwanted ions from said internal volume of said multipole ion guide while retaining the desired said range of m/z values of said ions by not applying the resonant frequency components corresponding to said desired m/z values of said ions to said poles of said at least one said multipole ion guide.

25. An apparatus according to claim 23, wherein said means to limit said range of m/z values of said ions includes trapping of a wide range of m/z values of said ions and ejecting unwanted m/z values of said ions by adjusting the amplitude of said AC and DC components of said voltages applied to said at least one said multipole ion guide such that the unwanted ion no longer fall in the stability region defined by said voltages applied to said poles of said at least one multipole ion guide.

26. An apparatus according to claim 23, wherein MS/MS capability with Time-OF-Flight mass analysis is achieved whereby the step of said selection of the range of m/z values is followed by a fragmentation of at least a portion of ions falling within said selected range of m/z values which is followed by mass analysis of a portion said fragment ion population by means of a Time-Of-Flight mass analyzer.

27. An apparatus according to claim 23, wherein MS/MS^n capability with Time-OF-Flight mass analysis is achieved whereby the step of said selection of the range of m/z values is followed by fragmentation of at least a portion of ions falling within said selected range of m/z

values said fragmentation producing the first generation fragment ions, said first generation fragmentation step is followed by a second said selection of a range of m/z values which includes the m/z value of at least one fragment ion species produced in the said first generation fragmentation step, said second m/z range selection is followed by fragmentation of at least a portion of ions falling within said second selected range of m/z values, the second said fragmentation step producing a second generation of said fragment ions, said steps of selecting said range m/z values of said ions followed by said fragmentation of at least a portion said ions whose m/z value falls within said selected range of m/z values can be repeated n-1 times past the first set of steps, where n is an integer greater than zero, wherein a portion of the resulting ion population is mass analyzed by means of a Time-Of-Flight mass analyzer.

28. An apparatus according to claim 27, wherein said means for controlling said electrical voltages applied to said poles of said at least one multipole ion guide and a means for controlling said electrical voltages applied to said electrode elements can be adjusted to trap ions in said at least one multipole ion guide during a portion of said MS/MS^n analysis steps.

29. An apparatus according to claim 28, wherein said means for controlling said electrical voltages applied to said electrode elements can be adjusted to cut off ions entering said ion guide during a portion of said MS/MS^n analysis steps.

30. An apparatus according to claim 17, wherein said mass analysis means can acquire mass spectra of a portion of the population of ions which exit said at least one multipole ion guide operated in non fragmentation mode followed by acquisition of mass spectra of a portion of the population of ions which exit said at least one multipole ion guide operated in said selected m/z range ion fragmentation mode whereby the mass spectra of said unfragmented ions is

subtracted from the mass spectra of selected said fragmented ions producing a mass spectra containing peaks of only fragment ions and the ions which were fragmented, said resulting subtracted mass spectrum contains MS/MS analysis information.

31. An apparatus according to claim 17, wherein said mass analysis means can acquire mass spectra of a portion of the population of ions which exit said at least one multipole ion guide operated in non fragmentation mode followed by acquisition of mass spectra of a portion of the population of ions which exit said at least one multipole ion guide operated in said multiple selected m/z range ion fragmentation mode whereby the mass spectra of said unfragmented ions is subtracted from the mass spectra of selected said fragmented ions producing a mass spectra containing peaks of only fragment ions, fragments of fragment ions and the ions which form which the first fragmentation occurred, said resulting subtracted mass spectrum contains MS/MS^n analysis information where n is an integer greater than zero.

32. An apparatus according to claim 31, wherein said means for controlling said electrical voltages applied to said poles of said at least one multipole ion guide and a means for controlling said electrical voltages applied to said electrode elements can be adjusted during the data acquisition period such that a portion of said ions produced by said ion source continuously enter said at least one multipole ion guide.

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